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PROCEEDINGS

....OF THE....

Natural Science Association

....OF THE....

UNIVERSITY OF TORONTO

PER ANGUSTA AD AUGUSTA

PUBLISHED BY ORDER OF THE ASSOCIATION
1893

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PROCEEDINGS

OF THE

NATURAL SCIENCE ASSOCIATION

OF THE

UNIVERSITY OF TORONTO.

Per angusta ad augusta.

PUBLISHED BY ORDER OF THE ASSOCIATION.

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PREFACE.

THE NATURAL SCIENCE ASSOCIATION, which, next to the Literary Society, is the oldest and one of the most influential undergraduate bodies in connection with the University of Toronto, was formed at a meeting of the undergraduates in the Honor Course in Natural Science held December 12th, 1879.

At the time of its formation it was stated that "the object of the Association shall be the encouragement of original scientific investigation and mutual assistance in the study of the natural sciences by discussions, lectures, papers and critical readings from scientific authors, or by the supply of such periodicals, magazines, etc., as shall be deemed advisable."

The Association has had a very successful history, judging both from the number and the quality of the papers read before it, and from the interest evinced in all of its proceedings by its members. The members now number several hundred.

It is now generally believed that students, to get the most benefit out of the special courses they may be pursuing, should be encouraged to take part in the proceedings of some Society—by reading papers and entering into the discussions on subjects in their special lines of work. In this way mutual assistance is given, and their interest is aroused more than it would be by a course of lectures, taking up the same time, from the most brilliant specialist. For this reason many universities provide a fund for the publication of the proceedings of such societies, carried on by students. It is hoped that next year this Association, and the other societies in connection with this University, will receive grants towards the publication of their proceedings.

During the session of 1892-3, numerous papers were read before the Association, and it is most gratifying that a large percentage of these were read by undergraduates lower than the fourth year. Owing to the desire of some members for more time for the completion of their papers before presenting them for publication, and to the indisposition of the General Committee to draw too largely on the funds of the Association at the present time, only a few papers are published in this issue.

Through the generosity of two of its honorary members, the Association is enabled to offer, annually, two medals for competition among its undergraduate members. Two prizes are also awarded annually. The conditions under which these are open for competition are given in the appendix to this volume.

This opportunity is taken to state that since the demolition of Moss Hall, the Association has been sorely in need of a room in which to store its effects. The General Committee earnestly hopes that this will be secured before next session.

May 1st, 1893.

LIST OF PAPERS READ.

President's Address	W. G. Miller, B.A.
Parasites of Fresh-Water Fish	W. G. MacCallum.
Errors of Observation	A. W. Connor.
Cell Division in its Relation to Heredity	T. McCrae, B.A.
Fermentation	Miss Curzon, B.A.
Symbiosis	R. W. Sheraton.
Nervous Localization in Reference to Phrenology	S. Silcox.
The Petroleum Industry of Ontario	N. McDougall.
A Mineral-Hunting Excursion	P. W. Currie.
Protective Mimicry	M. A. Chrysler.
Experiments on the Vapour Tension of Hydrochloric Acid Solutions *	F. B. Allan.
The Relation of Metabolism and Sex †	S. Silcox.
Instinct	G. More.
Dissociation	A. W. Connor.

* Awarded the Cawthorne Medal.

† Awarded the McMurrich Medal.

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Selections from the Papers Read before the Association during the Session of 1892-93:

THE RELATION OF METABOLISM AND SEX.

S. SILCOX.

THE consideration of sex is no new occupation for scientists. By theory and experiment they have endeavored to show what are the necessary conditions for the production of a male or a female individual. To such an extent has this question occupied the minds of biologists, that between five and six hundred theories have been advanced from time to time, each to be abandoned, relegated to the realms of the curio-seeker, a warning to successors to advance carefully, to build on sure foundations. Nor is it to be wondered at that this question should attract so much attention, especially when we note the gradual differentiation of male and female, as exhibited by a comparison of the lowest with the highest animals. In the former, a condition is found where there is no distinction of sex. In the latter there is a difference of habit, form, and function. Between are found all grades of differentiation.

Embryological study has especially increased the interest in the subject, for from it we learn that the connection between the sexes is closer than could possibly be surmised by the study of adult forms alone. From this we learn that there is first a condition of Germiparity, then Hermaphroditism, and finally, in the adult or before, Differentiated Unisexuality. Before the microscope and microtome were brought into use for studying the development of the ovum, it was believed that the animal lay preformed in all its parts in the egg. Modern scientific instruments have enabled observers to completely refute such an hypothesis. That sex does not manifest itself till a comparatively late period in development, would, *a priori*, lead us to suppose that environments might determine it.

Many circumstances have been thought to determine sex. The most generally accepted theory of late years is, that abundant nourishment produces females, while a partial starvation produces males. The process of fertilization, time of fertilization, age of parents, comparative vigor, etc., etc., have all been advanced as determining factors; and of these, the time of fertilization seems to be of most importance. According to Thury and Düsing, an ovum fertilized soon after liberation tends to produce a female, while an older ovum will rather develop into a male. Girou claimed to have proven the law for plants.

There must exist some fundamental difference in the sexes, which not only brings about the different functions, but likewise is the cause of secondary external organs, and also of accessory structures, such as horns, crests, dewlaps, manes, etc. Whatever circumstances are conducive to these fundamental characteristics, should likewise be conducive to the origin of corresponding sexual structures.

The object of this paper is to discuss the theory of sex as propounded by Geddes and Thompson in "The Evolution of Sex," which is, that sex is the expression of a fundamental difference of metabolic activity in the individual;—an organism in which katabolism is nearly equal to the anabolism is male; but if anabolism predominates largely, the animal is female.

To make the argument clear, we must have a proper conception of the meaning of the above terms. According to Charles, "the term metabolism is applied to such a series of chemical transformations as a body like albumen undergoes in its passage through the organism." If, then, synthetic processes predominate, a storing-up must follow, and an anabolic total results; but if the analytic or destructive metabolism is nearly equal to the anabolic (they can seldom be greater, for any length of time), a katabolic total results. Different kinds of food tend to different processes. Complex substances, like proteids, are unstable and decomposable, and the extent of the decomposition determines the amount of available energy for the organism. For example, complete combustion of grape sugar to carbon dioxide and water, furnishes 1,674,000 kgms. muscular work; when split up into alcohol and carbon dioxide, it supplies energy equivalent to 158,100 kgms. work; and split up into butyric acid, carbon dioxide, and hydrogen, 176,000 kgms. work are possible.

Organisms also differ in their powers of anabolism. Certain nerves have been shown to have an anabolic function, while others have a katabolic function.

Having considered metabolism, the next term in our premise is "Sex." What do the terms, male and female, denote? They are distinctive terms, and we now proceed to note the distinctions. This is an extensive question if fully examined, but we must generalize.

First, as to function. Whatever function the male element has in transmitting tendencies, or in supplying stimulus to excite development, it is readily seen that the female supplies nourishment to the fœtus, in the higher animals, both before and after birth. If oviparous, the female supplies nutritive material, sufficient to supply the embryo to a more or less perfectly developed state. Part of the ovum is formative material (protoplasm), and part nutritive material (deuteroplasm). The first is a result of the fusion of the male and female pronuclei. The latter is a purely female production. All the food taken is stored up, either into more complex compounds, *e.g.*, lecithin, nuclein, or into less complex, but still stored with a large amount of potential energy, *e.g.*, fat. It is evident the female has very little energy to spare.

Leaving aside the external sexual organs, we have to note the difference in activity of the male and female. Where the male is active and mobile, the female is passive and often sluggish, or of more sedative habits. Below vertebrates, males are generally smaller than females. The most striking example is that of the moth (*Orgyia antiqua*), where the male is winged, the female being wingless. The males of Aphides are winged, females rarely so. The difference is most marked in the ultimate sex-elements themselves, the spermatozoa being small and active, consisting of a large nucleus, with a small amount of protoplasm, and the ova, being large, with, absolutely and relatively, a much larger quantity of protoplasm.

In structure, there are the horns, manes, crests, dewlaps, etc., of males, which are either lacking or much smaller in females.

These can hardly be considered essential, useful structures, and accordingly are the external representatives of some internal force, of energy over and above that required for the animal economy. If it be argued that these are structures adapting the animal to its requirements as a fighting animal, then we claim that the predisposition to fight is a result of the same surplus of energy that is claimed to have produced these structures.

As to color, though there are exceptions, the male is usually more highly colored than the female, and endowed with greater powers of song. Where, however, color is highly developed the power of song is at a minimum, and *vice versa.* Both are probably the expression of the same force, and cannot exist at a maximum in the same animal.

This question of color is an important one, inasmuch as Wallace and others have made it so important a feature in the theory of "protective mimicry." We have not time now to examine the subject at length, and therefore take Wallace's summary on this question as follows:

1. "Color may be looked upon as a necessary result of the highly complex, chemical constitution of animal tissues and fluids. The blood, the bile, the bones, the fat, and other tissues have characteristic and often brilliant colors which we cannot suppose to have been determined for any special purpose as colors, since they are usually concealed. The external organs with their various appendages and integuments would, by the same general laws, naturally give rise to a greater variety of color."

2. "We find it to be the fact that color increases in variety and intensity as external structures and dermal appendages become more differentiated and developed. It is on scales, hair, and especially on the more highly specialized feathers, that color is most varied and beautiful.

3. "There are indications of a progressive change of color accompanying the development of tissues or appendages. Thus spots spread and fuse into bands, and when a lateral or centrifugal expansion has occurred, into variously-shaded or colored ocelli."

4. "As a general rule the colors of the two sexes are alike;

but in the higher animals there is a tendency to deeper or more intense coloring in the male, *due probably to his greater vigor and excitability.*"

His conclusion is the law of natural selection and protective mimicry. It does not seem to me, on his own summary, too much to conclude that male and female are fundamentally different, and that that difference may be accounted for by an anabolic nature for the one and a katabolic nature for the other.

And further, in proof of this latter interpretation, he states that male insects usually emerge first from the pupa, and referring to the display that male birds make of their plumage, he says, "It is no doubt a very curious and interesting phenomenon, and indicates a connection between the exertion of particular muscles and the development of color and ornament." He likewise quotes from Tylor: "Diversified coloration follows the chief lines of structure, and changes at points such as the joints, where function changes." Again he says: "*There is in the adult male, at all events, a surplus of strength, vitality and growth power, which is able to spend itself in this way* (*i.e.*, developing accessory plumes and colors) *without injury.*"

In connection with the view held in this paper, it becomes an absolute necessity to discuss the relation between nourishment and sex as stated in the general law, that abundance of nourishment produces females, while a lack in this respect tends to produce males. The data for this theory are very numerous, and may be summarized as follows:

(1) Yung, by feeding tadpoles on frog's meat, raised the percentage of females from 56 to 92.

(2) The fertilized eggs of the common (*Apis mellifica*) queen bee produce females, that is, workers; the unfertilized eggs produce males, that is, drones. A worker larva may, by special feeding, be developed into a queen. If an ordinary worker larva receives a little only of this "royal food," it becomes a fertile worker, but produces only drones.

3. Von Siebold made most elaborate experiments on the wasp, *Pollistes gallica* (*var. diadema Latreille.*) In this species the workers have sexual structures similar to the queen, and are capable of fertilization. His experiments, extending

over a period of four years, led him to the following conclusions:

In all cases the parthenogenetic offspring was male. The eggs, therefore, bring with them from the ovary the capacity of developing, independently of male influence, into males; the influence of sperm elements can change this and produce females.

Experiments on *Vespa holsatica*, *Nematus ventricosus*, showed that parthenogenetic ova produced males, while in *Lepidoptera*, *Psyche helix*, *Solenobia triquetrielea*, and *S. lichenella*, females resulted, males being very rare.

4. In Pollistes, the first broods were female. Male wasps were not produced till August. This does not seem favorable to the theory of nourishment.

5. In Aphides, females are produced parthenogenetically for nine or ten generations, till cold weather comes on, when both males and females are produced. If kept in a warm place, the parthenogenetic production of females may be continued for years without any males being born.

These apparently contradictory results can be harmonized by the theory for which we are now contending, but can hardly be taken as data from which to deduce the theory.

However, the nourishment theory has other strong facts to support it. Starved larvæ of butterflies produce males. Among crustaceans, unfavorable conditions seem to produce males (*e.g.*, *Artemia salina*). It has been contended that the same law holds among mammals, man included. It is claimed that males are more numerous after a war or an epidemic. In towns and prosperous families there seem to be more females, while males are more numerous in the country and among the poor. But we should not accept conclusions on this subject till data had been gathered from many countries, and over a large area in each. The fact may be considered from another standpoint. The air in country places contains more oxygen and ozone. There is greater activity, hence more complete assimilation. This brings about more complete decomposition of food, hence more energy is evolved and males are more numerous.

The argument for the nourishment theory is not complete without the evidence afforded in the botanical world. Among Homosporous Filicinæ it has been observed that only antheridia are produced on the prothallia, when spores have been sown thickly. Prantl has shown that this is due to insufficient nourishment and *especially to lack of nitrogen.* They may be transformed into normal prothallia by supplying the necessary food.

The archegonia usually grow on a cushion-like mass of tissue, behind the growing point, a position favorable for abundant nourishment. But in Hymenophyllum tunbridgengs there is no cushion, and the archegonia are produced on the margin, the antheridia growing on the under surface, where they perhaps would not be so well nourished as on the upper surface. In some cases (Marattiaceæ), antheridia grow on both sides and even on the cushion, which is on the *underside.* Equisetum arvense, E. limosum and E. palustre, likewise seem to produce antheridia, when insufficiently fed. In the arum basal flowers are female, apical flowers male. Shaded branches of conifers produce only male inflorescence.

We will now proceed to examine the physiological effects of food, of abundant and deficient nourishment.

Bunge classifies foods thus :—

1. Those which serve as sources of energy, and which can replace the exhausted constituents of the body—Proteids and fats.

2. Those which serve only as sources of energy—Carbo-hydrates, gelatin and *oxygen.*

3. Those which serve only to repair waste of tissue—water and inorganic salts.

With this classification in mind, let us consider the food of the three kinds of bees, as given by A. Von Planta :

	Queens.	*Drones (1 to 4 days.)*	*After 4 days.*	*Workers.*
Nitrogenous ...	45.15	55.91	31.67	51.21
Fatty	13.55	11.90	4.74	6.84
Glucose	20.39	9.57	38.49	27.65
Ash	4.06		2.02	

The food of queens is 69.38 per cent. water; of workers, 71.65 per cent.; and of drones, 72.75 per cent.

The above is qualitative, not quantitative. The table shows that queens and workers get food that can replace the exhausted constituents of the body, as well as supply energy, while the drones, though at first receiving constructive food, afterwards receive a large proportion of energy-supplying food (*i.e.*, glucose). This is about what is demanded in order to produce a male in accordance with the theory under discussion—first construction, afterwards destruction.

Perhaps the cases of starvation producing males may be explained similarly. A fasting animal uses first its glycogen, then its fat, and finally its proteids. A fasting animal then, or a poorly-fed animal, lives on these energy-producing foods and males result.

Those instances in which cold weather seemed to bring an abundance of males (*e.g.*, Aphides), might be accounted for in like manner. In cold weather more energy and heat-producing foods are used, hence katabolic offspring.

Mr. Cunningham, M.B., in an article in the *Quarterly Journal of Microscopical Science*, has given, at some length, the general effect of starvation on animal tissues. "The amount of blood supply becomes visibly diminished, and the blood current flows with diminished rapidity. The principal effect of defective nutritive supply seemed to be in a fatty change. This change or degeneration especially affected epithelial elements, containing a large proportion of living material and the blood cells." This might certainly tell against the formation of ova, but would scarcely tend to the production of spermatozoa, inasmuch as these are formed, according to embryological evidence, from primitive ova. We should expect at least a building up before the breaking down began. And this would necessitate the condition of abundant nourishment followed by defective nutrition.

As a matter of fact, just the exact condition of nourishment required in each case is a difficult question to solve. Too abundant nourishment, or at least defective assimilation, leads to obesity. Starvation produces fatty degeneration. The same result is reached in both from different causes. Evidently the condition of the animal as to its power of assimilation is of equal importance with the supply of food, as much or little food is quite indifferent, if it is not properly assimilated. The theory advanced in this paper is based upon the assimilating power of the animal.

The argument, then, thus far, is this: The animal is male or female because of some fundamental, characteristic nature, which, whether inherited, induced by fertilization, or by environment, gives distinctly male or female features, and these features are entirely secondary. They are effects, not causes, and these effects are in some way closely connected with the generative organs. Removal of the generative organs of any animal changes its whole nature. A male becomes far less combative, less active, develops fewer accessory structures, and is not of so deep a color.

Female deer have been known to develop horns, and hens to develop spurs, but "in such cases the ovaries are generally found to be diseased." Is it possible that the generative organs themselves contain the ultimate differences of sex, and that it is the continuity of this, and not the influence of environment, that determines the sex? Weismann holds somewhat of this view on Heredity—*i.e.*, the continuity of the germ-plasma, which he states as follows: "In each development, a portion of the specific germ-plasma which the parental ovum contains is not used up in the formation of the offspring, but is reserved unchanged to form the germ-cells of the following generation."

Prof. Balbiani first demonstrated this. He observed in Chironomus, before segmentation of the egg had at all advanced, two cells set apart externally. (These had nothing to do with the polar cells.) These isolated cells took no part in the development, but after awhile they sank inwards and became the rudiments of the reproductive organs. An early isolation has been observed in Sagitta, in leeches, Nematodes, in some Polyzoa, in Cladocera, and in some spiders.

We return to the question at issue, and discuss the connection between development and the theory advocated in this essay. In Rotifera, Balfour (Comp. Embryology) states that the early developmental stages of the male are closely similar to the female, the chief difference between the two consisting in the development of the male being arrested at a certain point. Is not this what we would expect from the theory? If a katabolic process continued for any length of time, development must be arrested—hence the smaller size of males among invertebrates generally. On the other hand, if anabolism constantly predominates, a storing-up of the surplus must follow, as in the female in the egg.

The changes that follow the age of puberty point to the same explanation. The deeper voice of the male, the growth of hair on parts of the body, the greater strength, all imply the development of a large store of energy.

Male fishes (*e.g.*, Catostomidæ) assume very bright colors during the breeding season. Lizards develop crests, some forms develop other accessory structures, such as claspers, etc., only at that time. No such development occurs in the female, and the power of song likewise distinguishes the male at this season.

When we consider the effect of removing the genital organs, the diseased organs of females (*e.g.*, in case of deer producing horns, and hens spurs), and the effect of reaching the age of puberty, we are led to conclude that the animal exhibits these characteristics as the result of some influence, which is the direct product of the genital glands. Perhaps the testes not only produces sperms, but secretes something else which has the effect of inducing a katabolic nature. This would not be without a parallel in animal physiology.

If the pancreas becomes diseased or is removed, diabetes results. If now a fresh pancreas from another animal be grafted in, the diabetes is cured, though the ingrafted pancreas does not act as a digestive gland. Its duct is destroyed, and it cannot pour its secretion into the alimentary canal, if any secretion were produced.

Removal of the thyroid gland causes a disease known as myxœdema. If the patient be fed on the thyroid gland of other animals, the symptoms of the disease disappear. If the thyroid gland of a sheep be grafted into the wall of the abdomen or into the mesentery, a cure is effected.

It would not be at all remarkable if the genital glands possess an analogous function. This remains to be proven by experiment.

The study of the facts thus placed before us, with many others, have led me to make the following inquiries, some of which I have attempted to answer, not conclusively, for time has not permitted that, but at least tentatively with a view to follow up the investigations at a subsequent period. Common hen's eggs have been used, but doubtless, as in Yung's experiments, larval stages of some animals that undergo slow and extensive metamorphosis would be more satisfactory in experimenting with oxygen.

Does the size of an egg affect the sex to any extent? *A priori*, we might reason that a large egg is the expression of a large storage of energy, which is at the service of the embryonic chick, that is, during the time that the yolk of the egg is being used up, more energy is supplied by the large egg than by a small egg, on the supposition that the yolks in each case form the same proportional part of the egg. Hence, in accordance with the theory under consideration, a male should result. If on the other hand the egg is comparatively small, there is less energy at command, and a female might result, though of course in either case the environment may so affect the metabolism, that the large store of energy at command might not be assimilated, and a small store might be made better use of than a large store, and thus no prediction could be made of the result.

So far as I have experimented I will not attempt to dogmatize. Eight eggs were incubated, four averaging about 64 grams and four 45 grams, with little variation. From the four light-weight eggs three embryos were obtained, and an examination of the sex showed that two were female, the third being doubtful owing to the sections not being well prepared. Only one embryo was obtained from the four heavy eggs, and it proved to be a male.

We can come to no conclusion from these facts, but the results are suggestive.

Would incubation in a highly oxygenized medium affect the metabolism, and, in consequence, the sex? It might be doubted whether the developing chick can take up any more oxygen than under normal conditions. But we know that the vascular area of the embryo lies close against the shell, and that blood is formed on the second day, and a quite elaborate circulation is in operation on the third day. Further, the allantois, which is the embryonic respiratory organ, is rapidly developing from the third day, and by the sixth or seventh day has reached large dimensions, and at a later period exhibits pulsating movements. These movements may, and probably do, increase the circulation, somewhat as the lungs may act in the adults, and oxygen may increase this rythmic pulsation, and hence increase the general assimilating power.

Even if Hæmaglobin were not present, we would be justified in supposing that there is some other oxygen-carrying compound in the blood, or that oxygen penetrates to all parts of the embryo, and respiration is carried on as in the lower, slightly-differentiated animals, where the absorption of oxygen and the excretion of carbonic acid take place over the whole surface of the body. However, according to Bunge, oxygen is necessary. He says: "It is well known that nearly all the lower animals which have no blood die at once without oxygen, and that this source of energy is indispensable to every cell. The higher animals require oxygen in the first stages of existence, even before the formation of blood corpuscles, as the respiration of a bird's eggs shows."

The attempt to incubate eggs in a highly oxygenized atmosphere was not a success. Eleven eggs were incubated, from which only three embryos were obtained. One of these was about five days old, at which age it had died; the other two were developed no further than a three-day chick, though still living, after incubating for a week. All the other eggs but one showed signs of development, a well-defined vascular area being formed in each case, but the embryo had, apparently, been re-absorbed. An examination of the specimens obtained showed nothing abnormal so far as I could discern, but the arrested development may have some significance, as this, according to Balfour (Comp. Embryology), is what occurs in male Rotifera at a certain age.

There are many other questions which suggest themselves in connection with this subject, which I hope to make the subject of experiment at some future time. What effect would incubation in an electric field produce ? Would incubation in sunlight or electric light affect the metabolism ? Would a limited supply of oxygen tend to produce females ? Meanwhile, time and space prevent further consideration.

EXPERIMENTS ON THE VAPOR TENSION OF HYDROCHLORIC ACID SOLUTIONS.

F. B. ALLAN.

In this paper it is proposed, after giving a short account of hydrochloric acid, and discussing some of the properties of aqueous solutions of the gas, to describe some experiments I have made to find the vapor tension of solutions of varying strength, and to draw some conclusions from the results of these experiments as to the relative degree of electrolytic dissociation in the solutions.

Aqua Regia was known to the Arabian Alchemists who prepared it from nitre, sal. ammoniac and vitriol, but Basil Valentine, in the fifteenth century, is the first who mentions hydrochloric acid. Glauber obtained it by the action of sulphuric acid on salt, and Priestley (1774) was the first to collect the gas over mercury. Priestley thought the acid was the oxide of an unknown element which he called murium, hence the name muriatic acid; but Davy (1810) showed it to be a compound of hydrogen and chlorine.

The acid occurs in the gases of volcanoes, in streams from volcanic regions and in the gastric juice of mammals. It may be prepared by the direct union of its elements, by the action of chlorine on many hydrogen compounds, by nascent hydrogen on silver chloride, and by sulphuric acid on sodium chloride.

Hydrochloric acid is a colorless gas with a strongly acrid odor, which fumes in moist air, but the dry gas does not color litmus. The gas may be solidified at 115.7°C., and the vapor pressure of the liquid acid at 0°C is about 26 atmospheres.

The gas is very soluble in water, 1 vol. water at 0°C and 760 m.m. dissolving 503 vols. gas.

At 1 metre pressure 1 grm. water dissolves .856 grms. acid.
“ 1 decimetre “ 1 “ “ .657 “

So that the gas appears to be an exception to the law of Dalton and Henry, which says that the solubility of a gas is proportional to the pressure upon it.

A pure saturated solution of the gas freezes below -40°C, and the solid has the composition represented by the formula $HCl. 2 H^2O$.

If a solution of the gas in water be distilled, the temperature rises to about 110°C, and the distillate has a constant composition as soon as the temperature becomes constant; the temperature and composition of the distillate both varying with the pressure.

If dry air be bubbled through a solution of the acid, the residual liquid is also found to have, after a time, a constant composition which varies with the temperature, and Roscoe and Dittmar have shown that this residual liquid has approximately the same composition as the distillate at the same temperature, as shown by the following table; columns I., II. and III. containing the results obtained by distillation of the solution, columns IV. and V. those obtained by passing air through the solution.

I.	II.	III.	IV.	V.
Pressure.	Boiling Point.	Percentage HCl.	Temp. of Residual Liquid.	Percentage HCl.
100 m.m.	61-62°	22.8	62°	22.9
210 “	76-77°	22.1	77°	22.2
300 “	84-85°	21.7	85°	21.7
380 “	91°	21.3	91°	21.4
490 “	97°	20.9	98°	21.1

In my experiments to find the vapor tension of hydrochloric acid solutions, the methods consisted in the passage of air through the solution till saturated and analysis of this air.

The air was passed through a bottle, several test tubes (each drawn out into several bulbs), and two Liebig's bulbs, all containing hydrochloric acid solution. From the hydrochloric acid solution, the air, now saturated with hydrochloric acid gas and aqueous vapor, at the temperature of the experiment, passed through potash bulbs, then through sulphuric acid bulbs, and from here to a large bottle of water, which acted as a pump.

The bulbs containing hydrochloric acid solution were kept under water, in the sink, and the tap left open to keep a constant temperature, and a calcium chloride tube was inserted between the water bottle and the sulphuric acid bulbs to prevent moisture going back to the sulphuric acid.

The last set of bulbs containing hydrocloric acid solution was weighed before and after the experiment; if it had not lost weight it was known that the air had been saturated before reaching that set. The increase in weight of the potash and sulphuric bulbs gave the total amount of hydrochloric acid and aqueous vapor in the air which had passed through the system. Analysis of the potash gave the amount of hydrochloric acid, and the difference the aqueous vapor. The volume of air which had passed through the apparatus was noted by observing the volume of water which had been allowed to flow out of the bottle. The temperature of the water in the bottle and the atmospheric pressure were also noted.

A more detailed account of the results of one of these experiments may be given:

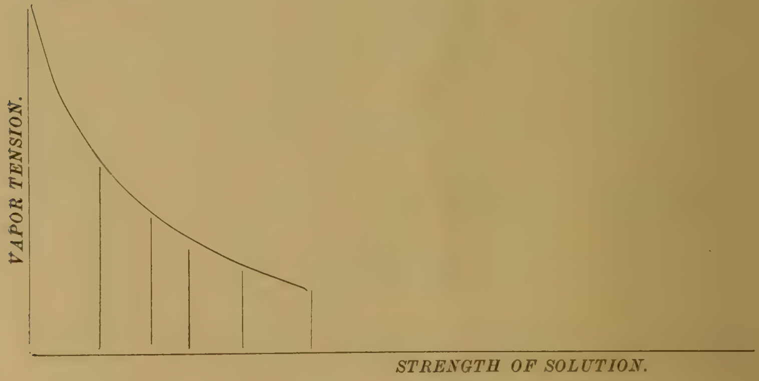
Temperature of water bottle	11°-12°	
Increase in weight of potash and suphuric acid bulbs	.0320	grms.
Weight of silver chloride found	.0998	"
Correction for impure potash	.0153	"
Silver chloride found (corrected)	.0845	"
Hydrochloric acid equivalent of chloride found	.0215	"
Weight of water found (.0320 – .0215 grms.)	.0105	"
Barometer of day	739.5	m.m.
Column of water supported by the apparatus	19.95	"
Temperature of water bottle	23° C.	
Vapor tension of water at 23° C.	20.89	m.m.
Pressure on air in water bottle	739.5 – (19.95 + 20.89) = 698.7	"
Volume of dry air at 23° C. and 698·7 m.m.	= 2000	c.c.
Reduced to dry air at 11° C. and 760 m.m.	= 1753	c.c.
.0215 grms. hydrochloric acid, occupying 1753 c.c., gives pressure of	5.72	m m.
.0105 " water gas, " 1753 " " "	1.84	"
Air at	760.00	"
	767.56	"
Vapor tension of hydrochloric acid gas $\frac{760}{767.56} \times 5.72 =$	5.67	"
Vapor tension of aqueous vapor $\frac{760}{767.56} \times 1.84 =$	1 82	"

Summary of results :

Solution.	*Temperature.*	*Acid Tension.*	*Aq. Tension.*
33.11%	11°C.	12.86 m.m.	7.23 m.m.
33.11 "	12.5°C.	14.15 "	4.85 "
30.75 "	12°-12.5°C.	5.96 "	—
30.75 "	11°-12°C.	5.67 "	—
29.41 "	11°-12°C.	4.74 "	—
28.52 "	11°C.	2.52 "	—
27.00 "	10.5°-11.5°C.	1.67 "	—
25.01 "	11°-12°C.	1.68 "	—

It was found that the apparatus was of no use to estimate the aqueous tension, as the water condensed before reaching the bulbs.

If a curve be drawn, taking as ordinates the vapor tension of the acid, and as abscissæ the strength of the solutions, and selecting the results of those experiments made at nearly the same temperature, it is found that all agree with it except one, in which possibly some of the solution was carried over mechanically.



The influence of an increase of temperature on the vapor tension may also be noted.

An explanation of the fact that this gas does not obey Dalton and Henry's law is given by the theory of electrolytic dissociation, and if we accept this theory, and accept Dalton and Henry's law as holding for this gas, then the amount of undissociated hydrochloric acid is proportional to the pressure, and the above curve will represent the undissociated hydrochloric acid present in solutions of varying strength; and the complement of this curve will represent the dissociation, if, instead of using as abscissæ the percentage strength of the solutions, we take the varying quantities of water with a fixed amount of hydrochloric acid.

My experiments, although they show the curve of dissociation between 33 per cent. and 25 per cent. acid solutions, afford no data to fix the absolute amount of dissociation. As my apparatus was not effective for weak solutions, I have made no experiments on acids below 25 per cent. in strength, but if this curve were continued down to the point where dissociation can be measured by other means, we would then be able to fix the amount of dissociation in these stronger solutions absolutely.

A MINERAL-HUNTING EXCURSION.

P. W. CURRIE.

THE object of this paper is to show that the study of Natural Science is not only one that can be pursued to advantage in the study and the laboratory, but also one that lends a greatly increased interest to pleasures which all agree to be in themselves worth seeking, even when not enhanced by the added charm of scientific interest. To one unacquainted with the most elementary truths of science, an excursion such as I am about to describe could not fail to be interesting; but the scientist has an incentive which, if all the charm lent by excitement and the beauty of the scenery were eliminated, would be strong enough to make the few weeks spent in this way an enjoyable time.

A glance at the map of Peterboro' will convince anyone that to a geologist or mineralogist it should be of especial interest. Its most striking feature, as all will observe, is the numerous lakes dotted over its surface. Closer observation will show that a continuous line of these lakes divides the country into two portions. This line separates the rocky mineral-bearing Archæan rocks from the more fertile Palæozoic country. The meaning of the last sentence is felt by everyone who crosses this line. The transition from fruitful, productive, thickly-settled country to the sparsely-peopled, rocky, wooded country on the other side is a very rapid one. In the former, comfortable, cosy farmhouses, good roads and a general air of prosperity prevail; in the latter, excepting where drift deposits have settled in the valleys, in which case the same air of comfort is seen, the houses are small, the farms generally rocky and unproductive, the farmers doing a good deal of hunting or prospecting, or in the winter working in the lumberwoods, to add to the scanty products of their industry on the farm.

On Saturday, September 24th, Mr. F. D. Roxburgh, '94, and I returned from an excursion into the Belmont gold mine district. We reached Norwood about six o'clock in the evening, twenty-four hours behind the time intended for the beginning of our cruise. This forced us hurriedly to make ready and set out for Stony lake. Mr. A. J. Raddon, '95, accompanied us on this trip.

A great deal had been said about the bad roads to Stony lake, and we found them in this regard quite up to our expectations. The pitchy darkness, intensified by the tall forest trees enclosing the road on both sides, did not improve matters any, so that the situation at times became quite weird and uncanny. One incident of the drive will be of interest to science students. A bright light on a stump attracted our attention. Out we jump to discover its origin, and to our astonishment find it proceeds from a small flat fungus which attaches itself to decaying stumps and logs like little shelves. The light emitted by it proved strong enough to enable us to see the time on our watches. Each of us took samples of the wonderful plant, but our interest in it waned when daylight arrived, as it then had a very ordinary appearance. But soon we come to a clearing, and then, after passing a small house and stable, the rig is stopped on the side of a steep bank. Hindered by the fog, we cannot see to the foot of the bank, but walking down we find we are on the shore of the lake. One of us goes back to the house just passed and gets the key of the house, *i.e.*, the summer cottage on the lake in which we are to stop, and of the boathouse.

We get out a large punt, stow our baggage in it, then set out for the island on which the house is, guided by the only two stars in sight, which are thought to lie in the direction of the island. This island is three-quarters of a mile from the shore. After rowing for a good while we strike land, but, to our dismay, land unknown to any of our party, although some of them think they know every nook and corner of the lake. Our feelings, lost at 12 o'clock on Saturday night on unknown waters, can be better imagined than described. We stop rowing and carefully consider the situation. It is decided to coast from island to island till some familiar spot is reached. At last, to the joy of all, the landing we are searching for is found. So we disembark, unload our baggage, and hurry up a rocky bank to the house. It is too foggy to make any observation further than that there is no soil, everything is solid rock. Some trees, however, are brought into view by our lantern. Hurriedly we open the house, make up the beds, and soon all are quietly sleeping.

Next day we make a tour of the island. We find it an immense boulder of gneiss, springing up out of the lake, its shores being steep and rocky everywhere but in the cove at which we landed, where the shore of the bay is formed of a bed of fine sand. The island is well wooded, and we find frequently veins of quartz showing themselves among the generally gneissoid rock. Even for the embedding of the flag pole earth could not be found, so it has to be supported by rocks and stones piled around it.

Monday morning we set off in a stiff breeze for Blue mountain, by far the most conspicuous object in our landscape. It appeared to be quite close, but our experience showed this to be deceptive. We hoist our sail, and soon are skimming rapidly over the lake, but a stronger gust than usual breaks the socket holding the mast in place; down flops the sail, and regretfully we take the slower and more laborious paddle for the rest of the way. Along our course we find the lake thickly dotted with islands, all rocky, like the one the house is on, but differing greatly in size and shape. Some are thickly wooded, while others are almost bare rocks. Soon we reach the mouth of Jack's creek. This creek generally is not navigable, but now it is quite high and we resolve to ascend it as far as possible. Soon we come to a timber slide, and here we have to portage. Our baggage is taken from the canoe and divided into three portions, of which each takes one and carries it to the head of the slide. Then all go back for the canoe. We find it easier to drop it into the water near the head of the slide than to wait till the quiet upper level is reached, but this turns out a great disadvantage as two of us get wet, one being almost carried back down the slide in the effort to keep the boat from being dragged down by the swift current. But at last this trouble is overcome, and we set out again on the quiet waters above.

Here a veritable glimpse of fairyland seems to open out before us, and several times we stop paddling and almost hold our breaths for fear we should lose some of the effect of the charming scene which confronts us. The banks of the stream, here about two feet high, are fringed with some large ferns which droop gracefully to the edge of the water, almost completely hiding the bank. Now the frost has tinged this fern a brilliant yellow. Behind and above this is a thick growth of dark green cedar, and still further back the large forest trees clothed in all the grandeur, of their autumnal coloring. Near us the water is calm, and reflects, mirror-like, the beautiful grouping and coloring of the shore; while, ahead, variety is given by the troubled, angry waters of a little rapid, foaming fretfully over the rocks that obstruct its pathway. Taken together, this is such an enchanting scene that it is with difficulty that we realize that we are not gazing in a dream on one of the groves in which Titania and Oberon hold their nightly revels.

But soon a second slide more formidable than the first confronts us, so we decide to leave the canoe here and not attempt a second portage. Accordingly, we divide up the necessary baggage and set off on our seven-mile tramp to the mountain. The trail is at first quite distinct and is easily followed, but when we begin our ascent of the mountain it becomes gradually harder to find, and several times is lost altogether, forcing us to spread out and carefully search for it again. As we near the mica mine, however, we find no difficulty, as the pieces of mica dropped along the way by former travellers is a sufficient guide. We find the mica mine nestling at the foot of the mountain, whose side is here quite steep. In front of the mine is a little lake, clear as crystal, and so calm that it looks like a sheet of glass spread out before us. The mountain we find is merely a very high mound of rock of the same nature as that of which we found the island composed. On the side from which we reached it, the ascent is quite gradual. There is generally quite a thick growth of trees and shrubs, but here and there we find places quite bare, smooth, and even as a table. We have gone quite around the mountain before reaching the mica mine, and here the descent is almost precipitous.

Arrived at the mica mine, we find in the large hole from which the mica is obtained a fine spring of clear, fresh water. A drink of it proves very invigorating, as we have had a long walk. Now two of us set about the preparation of dinner, while the third goes into the mine to gather specimens. Dinner being prepared, we eat heartily, then set to our explorations in good earnest. A small shanty has been built for the miners. Here we find many pieces of mica cut ready for shipment, also numerous blocks of wood cut to the sizes of mica generally used, and serving as measures for those who prepare the mica for shipment. The mica we find in quite large blocks, arranged in a very irregular way, and the blocks, too, we find to differ widely in size and shape. It caused us very little trouble to detach these blocks from one another, but the larger blocks were comparatively rare, so we had a good deal to detach before pieces were found worth taking away as specimens. Having exhausted this mine, we proceed about fifty yards further, where we find a mine, not so well developed, but with a good supply of mica in much larger sizes. Across the lake there is a still better mine, but we were told we could not possibly reach it without a guide.

Now we start for the peak of the mountain. We find it by no means an easy task to ascend, but when we reach the summit the labor involved is well repaid. Before us, a scene of beauty and picturesque grandeur, lies, stretched out as in a panorama, the country for miles around. We see long and widely-extended stretches of forest, with, at rare intervals, little patches of cleared land, marking the places where the scattered settlements are to be found. Interspersed with the forest are scattered numerous pretty lakes. We could see nine, but thirteen of them have been counted on a clear day. Here we lingered long, drinking in the beauty of the scene, then hurried down and started for home.

All went well, we soon reached our boat, and headed for the copper mine. When we reached it the sun was setting, so we needed to hurry. We found the mine itself filled with water, so we could see only the top of the vein. There it is about three inches wide, and the ore appears a splendid sample. A strong American firm had just bought the mine, and were getting in the machinery preparatory to beginning work. At this mine we got some excellent specimens of calcite. A little past the copper mine is a graphite mine, but it, too, was filled with water, and our samples on this account are not very good. They show, however, the presence of a graphite vein near them. Now we turned for home.

It was a busy night, as we had to prepare to meet the steamer in the morning. To do this, we had to go to Mr. Crow's, distant three-quarters of a mile, and back, prepare and eat breakfast, pack our baggage, lock up the house, and paddle against a strong wind to Mount Julien, four miles, all before eight o'clock. However, systematic work tells, and we arrive at the place long enough before the steamer to ascend the mountain and enjoy the view from its summit. Across from Mount Julien is Eagle Mount quarry, from which a large amount of building stone is shipped. A good deal of this stone was used in Toronto last summer by the street railway. Soon, however, the smoke of the approaching steamer warns us to descend. We leave our canoe and part of our baggage in charge of the Mount Julien hotelkeeper, then board the steamer for Bobcaygeon. Here we arrive about two o'clock, obtain the necessary information, then set out for the mines.

Soon we enter a rocky country, in which, however, there is generally more soil than in that before described. After driving about ten miles we come to Mr. Miller's, to whom we apply for information. The nickel mine is on his farm, on the opposite side of the little lake which is just ahead of us. But no boat is available in which to cross it, so he says we must go back three miles, drive across three to Gilmore's depot, and then seven north to the nickel mine; but he says to go to the lead mine first, and come back to spend the night at Gilmore's depot. About four o'clock the lead mine comes in sight. Above ground we find very little to attract attention, a derrick used for raising the ore, and a small house in which the powder and dressed ore are stored, being all that is to be seen. At the brink of the mine we find a large, irregular shaft, about seven feet by ten, which the miner tells us is about one hundred and twenty feet deep. He is a Cornishman, and soon expresses his contempt for such mining operations as he finds here. At first he is very averse to giving us any information, but soon he warms up and we find him very obliging. The galena we find an excellent sample. We are told that it bears a very large percentage of silver; in fact, it is for the silver in it that the mine is being worked. We pick up here also some very good samples of calcite. The miner tells us that the distribution of the galena in the vein is very irregular, they sometimes finding large pockets holding tons of the ore, while, at other times, the galena carried hardly pays the cost of working.

Before long he asks if we would like to go down to where they are at work, warning us, however, that it is wet and not very clean. We are, however, eager to go, so he gets a candle and starts down ahead of us. We descend by a smaller shaft than the one described, climbing down a succession of ladders. We go down about twenty feet before it is dark enough to require the candle to be lit. At about thirty feet the water begins to drip down. It feels quite chilly. About forty feet down a drop of water falls on the candle and puts it out, and suspended on the ladder in the dark, we feel the weirdness of the situation. However, the candle is soon re-lit and down we go, till at a depth of eighty feet we strike the level on which they are working. Here we find a large gallery, about seven feet square and fourteen feet long, but its walls are very rough, and in the dim light we go along it with many a stumble. The wall rock is very dark, almost black, but the course of the vein can be readily traced in it. We find numerous holes drilled and charged, all ready for the firing of the blast. We are told that there is little danger to the one who lights them—he has only to stand aside a short distance. When we reach the top we carefully select our specimens, then go away to prepare supper.

The sun is setting as we leave. There is a new moon, but it sets just as we turn our horse into the unknown, unsettled wild, through which we have to drive three miles to Gilmore's depot. We dread this part of our drive, yet soon find it much worse than we had feared. In fact, so bad is it that, if possible, we would gladly turn back; but even this is denied, for, as the bush grows right up to the road, we can not turn, and must go on. Disgusted with this method of travelling, two of us jump out and walk, leaving the third to drive. The farther we go the worse it gets, but fortunately, as we are on the verge of despair, a light gleams ahead, and with a cry of joy we hasten toward it. We find it proceeds from a settler's shanty, so we go and enquire about the rest of the way to the depot. We find it a mile away, and a very bad road. We ask if it is any worse than what we had passed, but the only reply is a peculiar smile, intimating that if we think the roads passed bad, we have much to learn before we leave Galway. Mr. Woods then offers to walk ahead with a lantern, but we have had enough, and we beg to be allowed to stay. He is not very willing, but his wife takes pity on us, and says we may. We are given a comfortable bed and a good breakfast, and in the morning set off again in good spirits.

The roads, however, we find quite up to the received description, so only one rides. Soon we reach Gilmore's depot, and find it a place where lumbermen's supplies are stored. There are large stables and barns and several log houses affording accommodation for any of the men and their horses. But we do not linger here. The roads get no better, so coming to a settler's, two miles further on, we go in and ask how far we are from Bass Lake, and what the roads are like. We find it five miles with roads worse than ever. We also find that this is the last settler till we reach the lake, that there only one settler lives, and beyond that there are no more. We feel that we are nearing the limits of civilization. Tired of driving we ask to leave the horse. Our request is granted. So on foot we start off on our five-mile tramp, which we must accomplish each way in an hour or miss the steamer. We find the road very rough, having to jump from log to log through the low places, but well within the hour we reach the clearing and are soon directed to the mine.

Here we find out what it is to have mining enthusiasm. All is excitement. The new owner of the mine has taken possession and is busy drilling for his first blast when we reach there. He is quite obliging and willing to give us every information. He feels quite confident of the result of the shot, and says: "If you will only wait a few minutes you will get specimens worth carrying away." But this we cannot do, so choosing as well as we can from what is lying around, we set off to where we left the horse.

Hurriedly we prepare dinner, then off to catch the boat, as we have little enough time. We are only three or four miles from Bobcaygeon when all get into the buggy, and we can drive with comfort. We reach Bobcaygeon ahead of the steamer.

As we jump from the rig a man accosts us, asking if we have been looking for minerals. We tell him we have, and receive an invitation to go to see some of his. Here we find an excellent collection of the ores of the district, but many of them are rare, and we are much too ignorant to name them all at sight. He gives us some fine specimens of hæmatite, some siderite, a platinum ore which has unfortunately since been found to contain no platinum, and some pieces of tourmaline showing well its crystal structure.

Leaving him we find the steamer ready, so off we start on our return trip. We find all are interested in our success, and so are forced to show and describe our samples to numerous enquirers. When nearing Lakefield, the captain kindly offers us the use of the boat to save us the trouble of setting up our tent. In the morning we take train for Peterboro', the part of the Otonobee intervening being a foaming torrent much too rough for our frail bark.

From Peterboro' the trip down the Otonobee is a delightful one. Along this large and beautiful stream, we find that the gneiss has given way to limestone, the rough rocky country to fine arable land. Everywhere fine orchards, beautiful houses, and carefully cultivated farms attest the intelligence and thrift of the community, as well as the productiveness of the soil. About two o'clock a little steamer overtakes us. We hail her and ask a ride. The request is granted, and now with accelerated speed we continue our course down the stream. Soon Rice lake is reached, and just before entering the village of Harwood, we leave the steamer and are quietly wafted by a gentle breeze to Idlewyld, the famous summer resort on Rice lake. We reach it just before night.

In the gathering twilight on a pretty level cape in front of the hotel we put up our tent, arrange our cots, prepare and by the light of a fine large bonfire eat our evening meal, after which we lazily lounge in the dim light, and give free scope to our imagination. Dull would be the mind which would not be aroused by the picturesqueness and romance of the scene. The beautiful spot on which we are encamped, the tall trees with the wind weirdly whistling through them, the lake with the gurgling of its waters as they lap the shore, the weird shadows thrown by our large camp-fire, combine to recall to our mind romantic incidents of life afield. But the day has been a busy one, and we soon retire.

Morning ushers in a changed scene. The waters gently rippling at night now are lashed to foam. Madly in their eager course, the white caps race one after the other, loudly and threateningly whistles the wind, but these sounds, heralding an exciting sail, merely prove an incentive to us. Hurriedly breakfast is prepared, the tent taken down, everything cosily packed into the boat. Then hoisting the sail, off we go on an intensely exciting, yet a very enjoyable trip. Madly after us dash the waves, but vainly, for our boat rushes forward so rapidly that they cannot overtake us. An hour's sail brings us to Margaret's island at the foot of the lake, and here we remain for dinner. We stay here for a long time, not caring to venture on the stormy water, but a lull comes about three o'clock, when we go to the mainland and spend the afternoon on the splendid farm of Mr. Birdsall. In addition to his fine stock, we find a really good collection of minerals, which we examine with much interest. Afterwards we continue our sail uneventfully down the beautiful scenery of the Trent to Hastings, where friends, hearing our songs, come out and gladly greet us on our return. From here we arrive home, conscious that our trip has been a very enjoyable and, we trust, a profitable one.

REGULATIONS AND RULES OF ORDER

OF THE

NATURAL SCIENCE ASSOCIATION OF THE UNIVERSITY OF TORONTO.

REGULATIONS.

SECTION I.—THE ASSOCIATION.

1. The Association shall consist of Graduates and Undergraduates, in the Honor Course in Natural Science, and such students as are taking the courses of Analytical and Applied Chemistry, and Mining Geology in the School of Practical Science.

2. It shall be called THE UNIVERSITY OF TORONTO NATURAL SCIENCE ASSOCIATION.

3. The object of this Association shall be the encouragement of original scientific investigation, and mutual assistance in the study of the Natural Sciences by discussions, lectures, papers, and critical readings from scientific authors, and by the supply of such periodicals, magazines, etc., as shall be deemed advisable.

4. The President and Professors of the University of Toronto and the Faculty of the School of Practical Science shall be the Patrons of the Association, and shall have the right of attendance at all its meetings.

SECTION II.—MEMBERS.

1. The Association shall consist of four classes of members, viz., Ordinary, Life, Corresponding, and Honorary Members.

2. Ordinary Members shall consist of Graduates, Undergraduates, and other students, not Undergraduates, who are taking the Honor Course in Natural Science and in Chemistry and Mineralogy ; and such students who are taking the courses of Analytical and Applied Chemistry, and Assaying and Mining Geology, in the School of Practical Science.

3. Life Members shall consist of such Ordinary Members as shall have paid four years' membership fees to the funds of the Association.

4. Corresponding Members shall consist of such Graduates or Undergraduates in Natural Science, not resident in Toronto, as may be desirous of contributing to the objects of the Association.

5. Honorary Members shall consist of (1) all ex-Presidents of the Association ; (2) such gentlemen as shall be elected by a vote of five-sixths of the members present at any regular meeting of the Association.

6. Candidates for membership shall be nominated at a regular meeting preceding their election.

7. A minute of all notices of motion and names of all candidates for membership shall be posted up in the Entrance Hall at least one week before their election, and any member may, by private notification to the President, require that a ballot be taken for the election of such candidates.

8. In case no ballot be demanded before the next regular meeting of the Association, the President shall announce at such meeting the names of the candidates proposed, and declare them duly elected. In case a ballot is demanded, the President shall announce the same without disclosing the name of the member who requested it ; the ballot shall be taken in the usual manner, and the votes of five-sixths of the members present shall be necessary for the election of such candidate.

9. No Ordinary Member shall be entitled to any of the privileges of the Association, after the second regular meeting, until he has paid his fees for the year.

SECTION III.—OFFICERS.

1. The officers shall constitute the General Committee of the Association, and shall consist of a President, 1st and 2nd Vice-Presidents, Secretary, Treasurer, Curator, and a representative from each year.

2. The Election of Officers shall take place, yearly, by ballot, at the Annual Meeting, except the representative of the first year, who shall be elected at the third regular meeting of the following session.

3. Candidates for office shall be nominated at the regular meeting preceding the election.

4. Only Graduates with Honors in Natural Sciences, or Honorary Members of this Association, or a Fellow in one of the Natural Science Departments, shall be eligible for the office of President ; the 1st Vice-President shall be a Graduate with Honors in Natural Sciences ; the 2nd Vice-President and Secretary shall be chosen from those entering their fourth year ; the Treasurer and Curator from those entering their third year ; and the other members of the committee, one from each year.

5. The President, or, in his absence, the Vice-Presidents, or an ex-President, or Graduate Member, at the request of the President, shall preside over all meetings of the Association, enforce the due observance of the Constitution, decide all questions of order, announce the result of all voting, and give the casting vote in case of a tie.

6. In the absence of both the President and Vice-President, the members present may choose one of their number to act as Chairman, and perform the duties of the President.

7. The Secretary shall keep full and correct minutes of the proceedings of all meetings of the Association, conduct all correspondence under the direction of the President, keep the roll, and prepare and sign the notices of all meetings of the Association.

8. The Treasurer shall receive and account for all moneys belonging to the Association, shall, under the direction of the General Committee, pay all expenses incurred by the Association, and before the Annual Meeting, shall submit his report to two auditors appointed at a previous meeting. He shall also keep a roll book, in which shall be entered the name of every member of the Association, with the date of his admission, and of each payment of fees made by him.

9. The Curator shall have charge of all property of the Association, except that in the hands of other officers, and shall enforce the rules relating thereto, subject to an appeal to the General Committee, to whom he shall report at least every two months. It shall also be the duty of the Curator to obtain from competitors for Medals or Prizes the theses or collections offered by them for the above purpose, and to see that the same are in the hands of the Examiner before March 1st.

10. Every officer of the Association shall, at the conclusion of his term of office, deliver to his successor all property of the Association in his possession, and such successor shall thenceforth be responsible for the safe keeping of the same.

SECTION IV.—COMMITTEES.

1. The General Committee shall have power to make By-laws for conducting the business of meetings of the Association, shall select subjects, and make appointments for all regular meetings, and shall be responsible for the due and regular supply of periodicals, etc.

2. Their meetings shall be held at least once a month, five members forming a quorum, and they may appoint one of their number as a permanent Secretary of Committee.

3. They shall submit to the Association, at the Annual Meeting, a list of periodicals, etc., recommended to be supplied for the succeeding year, and shall at that meeting present a report upon the business of the year.

4. Special committees of not less than three members may be appointed for any purpose, and such committee shall continue in office until discharged by vote of the Association.

5. The member first named on such committee shall be Convener thereof, but the Committee may, at its first meeting, appoint a Chairman and Secretary. A majority of the Committee shall constitute a quorum.

6. The minutes of every such committee shall be kept in the Special Committee Minute Book, which shall be deposited with the Secretary of the Association, as soon as the Committee has reported.

Section V.—VACANCIES.

1. In case any officer of the Association is absent from three consecutive meetings of the General Committee, it shall be the duty of the Committee to report the same forthwith to the Association, who may, at their discretion, declare such office vacant.

2. Vacancies occurring under the foregoing article, or from any other cause, shall be filled in the same manner as at the annual election.

Section VI.—MEETINGS.

1. The regular meetings of the Association shall be held every second week, the day and hour to be appointed by the General Committee.

2. The Annual Meeting shall be the last regular meeting of the year.

3. Appointments for regular meetings shall be posted in the Entrance Hall one week previous to such meeting.

4. The General Committee shall have power to call a special meeting of the Association at any time, by giving at least 24 hours' notice.

Section VII.—THE PROPERTY OF THE ASSOCIATION.

1. The whole of the property and effects of the Association, of what kind soever, shall be vested in the General Committee of the Association, and subject to its control.

2. All papers and contributions of any kind, which may be read or presented to the Association, shall be considered the property thereof, unless there shall have been some previous arrangement to the contrary.

3. Papers read before the Association, as shall be deemed worthy by the General Committee, shall be published by it with the consent of the author, and no communication made to the Association shall be published by any other person but the author, without the previous consent of the General Committee.

4. The above mentioned property, together with all periodicals, books, apparatus, etc., purchased by the Association, shall be in charge of the Curator.

5. Members of the Association may obtain from the Curator any of the above mentioned property, subject to the regulations of the General Committee.

6. Any member obtaining any property of the Association shall be responsible for the safe-keeping thereof, and shall make good any loss sustained while in his possession.

7. The Curator shall keep a book in which he shall enter the name of everyone who obtains any of the property of the Association, the name of the article, and the date of its removal and return.

SECTION VIII.—FINANCE.

The Annual Fee for Ordinary Members shall be fifty cents.

SECTION IX.—ALTERING THE REGULATIONS.

1. Alterations in the Regulations shall be discussed only at the Annual Meeting, or at such other meeting as the General Committee may appoint, and two weeks' notice of motion of such change shall be given.
2. No such alteration shall take place without receiving the votes of two-thirds of the members present.

MEDALS.

"THE McMURRICH MEDAL."

(AWARDED BY W. B. M'MURRICH, ESQ., M.A., Q.C.)

"THE CAWTHORNE MEDAL."

(AWARDED BY F. T. SHUTT, ESQ., M.A.)

CONDITIONS.

1. The competition for the above medals shall be open to Undergraduates of the University of Toronto, who are pursuing an Honor course in Natural Sciences, and who are members of the Natural Science Association.
2. The "McMurrich Medal" shall be given for the best thesis on some subject in one or other of the branches of the Biological Sciences (the term *biological* to be considered in its etymological sense), special preference being given to those which indicate original research.

The "Cawthorne Medal" shall be given for the best thesis on some subject in one or other of the Physical Sciences (including Chemistry, Mineralogy, and Dynamical Geology), special preference being given to those indicating original research.

3. All competing essays shall be read at least in outline form at a regular meeting of the Association.
4. The theses for competition shall be sent in, on or before the first day of March in each year, to a committee (one for each medal) of the University of Toronto Natural Science Association appointed by the members of the Association at the last meeting of said Association in Michaelmas term.
5. The said Committees shall award the medals and bring in their reports at the Annual Meeting of the said Association.
6. The donors shall be *ex-officio* members of the said Committees.
7. No member shall be eligible to compete for a medal unless he has paid fees to the Association for each year of his course, and has attended at least two-thirds of the meetings of the Association held during the year in which he desires to compete.
8. No medal shall be awarded unless the Committee deem the thesis worthy of such an acknowledgment.
9. A winner of a medal shall not be allowed to compete a second time.

PRIZES.

To encourage the study and collection of Natural History specimens, the Natural Science Association offers two prizes, each of the value of eight dollars, to be awarded annually according to the following regulations :—

1. One prize shall be awarded for the best Botanical collection.

2. The other prize shall be awarded for the best collection illustrative of any other department in the Natural Sciences.

3. The collections to be Canadian and the result of the competitor's own work.

4. The collections are to be handed in on or before the 15th of February, to an examining committee appointed by the Association at the last regular meeting in January, in each year.

5. The prizes to be given in books, selected by the successful competitor.

6. Any undergraduate member of this Association in actual attendance at lectures may compete for either prize.

7. No member shall twice receive a prize in the same department.

8. No member shall be eligible to compete for a prize unless he has paid fees to the Association for every year of his course, and has attended at least two-thirds of the meetings of the Association held during the year in which he is a competitor.

9. No prize shall be awarded unless the collection exhibit a certain standard of excellence.

RULES OF ORDER.

1. The order of business at the regular meetings of the Association shall be as follows :—

(*a*) Minutes read, approved, and signed by the Chairman.
(*b*) Election of Members.
(*c*) Introduction of New Members.
(*d*) Nomination of Candidates for Membership.
(*e*) Business arising out of the Minutes.
(*f*) Communications received.
(*g*) Business from the General Committee.
(*h*) New Business.
(*i*) Nominations for Office and for Committees.
(*k*) Reading of Papers, etc., as announced by the programme.
(*l*) Roll Call.
(*m*) Elections and Appointments for Office and Committees.
(*n*) Announcements for the next Regular Meeting.

2. The order of business at the Annual Meeting shall be as follows :—

(*a*) Minutes read, approved, and signed.
(*b*) Reports of General Committee and Treasurer.
(*c*) Reports of Special Committees.
(*d*) Business arising out of the Minutes.
(*e*) Discussion of the Constitution.
(*f*) Roll Call.
(*g*) Election of Officers for the ensuing year.